

PROCEEDINGS OF SPIE

Oxide-based Materials and Devices X

David J. Rogers

David C. Look

Ferechteh H. Teherani

Editors

3–7 February 2019

San Francisco, California, United States

Sponsored and Published by

SPIE

Volume 10919

Proceedings of SPIE 0277-786X, V. 10919

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Oxide-based Materials and Devices X, edited by David J. Rogers, David C. Look,
Ferechteh H. Teherani, Proc. of SPIE Vol. 10919, 1091901 · © 2019 SPIE
CCC code: 0277-786X/19/\$18 · doi: 10.1117/12.2532003

Proc. of SPIE Vol. 10919 1091901-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Oxide-based Materials and Devices X*, edited by David J. Rogers, David C. Look, Ferecheh H. Teherani, Proceedings of SPIE Vol. 10919 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510624801

ISBN: 9781510624818 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$18.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.



Paper Numbering: Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

vii	Authors
ix	Conference Committee

KICK-OFF SESSION

- 10919 03 **ZnO as a platform for quantum photonics (Invited Paper)** [10919-95]
10919 05 **Strategies for high-performance perovskite solar cells (Invited Paper)** [10919-47]

ULTRA WIDE BANDGAP OXIDE SEMICONDUCTORS: DOPING AND BAND STRUCTURE

- 10919 0Z **Hydrogen passivation of calcium and magnesium doped β -Ga₂O₃** [10919-31]
10919 10 **Ga vacancies and electrical compensation in β -Ga₂O₃ thin films studied with positron annihilation spectroscopy (Invited Paper)** [10919-4]

ULTRA WIDE BANDGAP OXIDE SEMICONDUCTORS: APPLICATIONS

- 10919 13 **Gallium-oxide trench-type devices (Invited Paper)** [10919-33]
10919 16 **DC and dynamic switching characteristics of field-plated vertical geometry β -Ga₂O₃ rectifiers (Invited Paper)** [10919-35]

2D MATERIALS AND QUANTUM STRUCTURES

- 10919 17 **Electrical properties of BeMgZnO/ZnO heterostructures with high-density two-dimensional electron gas (Invited Paper)** [10919-36]
10919 19 **Short infrared wavelength quantum cascade detectors based on non-polar ZnO/ZnMgO quantum wells (Invited Paper)** [10919-38]
10919 1A **Surface plasmon induced dramatic reflection reduction due to subwavelength coupling in indium-tin-oxide/lithium niobate** [10919-39]

OXIDE-BASED ENERGY HARVESTING AND SOLAR I

- 10919 1G **On the role of different paramagnetic centers in conducting nickel oxide thin films (Invited Paper) [10919-46]**
- 10919 1H **p-Type thin film field effect transistors based on lithium-doped nickel oxide channels grown by pulsed laser deposition (Invited Paper) [10919-96]**
- 10919 1J **Synthesis and characterization of SnO₂/graphene transparent conducting films [10919-49]**

OXIDE-BASED ENERGY HARVESTING AND SOLAR II

- 10919 1K **Environmentally friendly approach via solvent-free processed perovskite solar cells (Invited Paper) [10919-50]**

PHOTON-INDUCED PHENOMENA IN OXIDES

- 10919 1P **Enhancement in optical properties of ZnO nanorods by UV ozone treatment [10919-57]**

TUNING TRANSMITTANCE AND REFLECTANCE FROM UV TO IR

- 10919 1S **Exciting and confining light in Cr doped gallium oxide (Invited Paper) [10919-26]**
- 10919 1W **Transparent and ultra-flexible PEDOT:PSS/ITO/Ag/ITO on Parylene thin films with tunable properties [10919-61]**

OXIDE-BASED GAS SENSORS

- 10919 1X **Optical gas sensing properties of gold-nanoparticle incorporated LSTO films at high temperature (Invited Paper) [10919-62]**

SPECIALIZED CHARACTERIZATION

- 10919 21 **Non-contact surface temperature mapping of alpha-alumina using a Raman scattering method (Invited Paper) [10919-67]**
- 10919 22 **Zinc-oxide nanowires characterization using optical reflectance [10919-68]**
- 10919 23 **Role of microstructure and stress evolution on the elastic constants of multiferroic oxide-based thin films (Invited Paper) [10919-69]**

- 10919 24 **Electron beam induced modifications in third harmonic process of spray coated Mn: ZnO nanostructures (Invited Paper)** [10919-70]

OXIDE NANOSTRUCTURES AND APPLICATIONS

- 10919 25 **Photocatalytic properties for different metal-oxide nanomaterials (Invited Paper)** [10919-71]
- 10919 26 **Surface engineering using compounds of titanium nanocoatings for silicon-based optical devices** [10919-74]

TUNING ELECTRICAL PROPERTIES

- 10919 2B **Oscillation electron model of mixed copper-lanthanum oxide crystals** [10919-79]

EMITTERS AND DETECTORS

- 10919 2C **Intersubband absorption at normal incidence by m-plane ZnO/MgZnO quantum wells (Invited Paper)** [10919-80]
- 10919 2D **Efficient white-light emission from Zn₂GeO₄ nanomaterials (Invited Paper)** [10919-81]

POSTER SESSION

- 10919 2F **Investigating time-varying phosphorous doping effect on the structural and optical properties of ZnO thin films** [10919-83]
- 10919 2G **High-temperature oxygen sensing behavior of perovskite films on the optical fiber platform** [10919-84]
- 10919 2H **Enhanced optical properties with the assimilation of boron and phosphorus dopant in co-doped ZnO thin film** [10919-85]
- 10919 2I **Augmenting optical and structural properties in Zn_{0.85}Mg_{0.15}O thin film with P-B co-doping** [10919-86]
- 10919 2J **Interdependence of Ar and O₂ partial pressure on the properties of RF sputtered Zn_{0.85}Mg_{0.15}O thin film** [10919-87]
- 10919 2K **Doped SnO₂ nanoparticles for solar-cell application** [10919-88]
- 10919 2L **Enhancement of photocurrent and responsivity of Zn_{1-x}Mg_xO (x=15%)-based ultraviolet detector by UV-ozone treatment** [10919-89]

- 10919 2M **Enhancement in optical properties with suppression of defect states by UV-ozone processing in RF sputtered $Zn_{1-x}Mg_xO$ ($x=15\%$) thin film [10919-90]**
- 10919 2N **Improvement in performance characteristics of $Zn_{(1-x)}Mg_xO$ ($x=15\%$) thin film transistor (TFT) with UV-ozone treatment [10919-91]**
- 10919 2O **Design, fabrication, and characterization of a disordered one-dimensional broadband photonic bandgap structure [10919-92]**
- 10919 2P **Characterization of ZnO and Fe doped ZnO nanoparticles using fluorescence spectroscopy [10919-93]**
- 10919 2Q **Characterization of Mn doped ZnO wrinkle-network nanostructured thin films deposited by sol-gel spin coating technique [10919-98]**

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

- Abernathy, Harry W., 2G
Adam, Rania E., 25
Alam, Md Jawaid, 1P, 2L, 2M, 2N
Alisafaee, Hossein, 2O
Alonso-Orts, M., 1S
Antony, Albin, 24
Appaiah, Kumar, 26
Avrutin, V., 17
Ayele, Fekadu H., 23
Baldini, Michele, 10
Bangera, Ankitha E., 26
Bazylewski, Paul, 1G
Billing, Dave G., 23
Bourouina, Tarik, 22
Bousseksou, Adel, 19
Bove, Philippe, 1H
Buric, Michael P., 21
Carey, Patrick, IV, 16
Castañeda, J., 1J
Chakrabarti, P., 2Q
Chakrabarti, Subhananda, 1P, 26, 2F, 2H,
 2I, 2J, 2L, 2M, 2N
Chan, Wai-Kin, 1K, 2K
Chang, Chin-Wei, 16
Chauveau, Jean-Michel, 19, 2C
Chavan, Vinayak, 2H, 2I
Chen, Wei, 2K
Chen, Yen-Ting, 16
Chorpening, Benjamin T., 21
Colombelli, Raffaele, 19
Comins, Darrell J., 23
Couteau, C., 03
Derelle, Sophie, 19
Dikshit, Ashutosh, 2Q
Ding, K., 17
Djuršić, Aleksandra B., 05, 1K, 2K
Dolado, J., 2D
Dwivedi, Jishnu, 24
Dwivedi, Shyam Murli Manohar Dhar, 2L
Elhag, S., 25
Enríquez, C., 1J
Erfan, Mazen, 22
Esparza, K., 1J
Ezugwu, Angela Ebere, 1G
Fan, Qi Hua, 1W
Fanchini, Giovanni, 1G
Fernando, Mihiri, 2P
Geng, W., 03
Ghadi, Hemant, 1P, 2F, 2H, 2I, 2J,
 2L, 2M, 2N
Ghosh, Anupam, 2L
Ghosh, Chiranjib, 2L
Girard, J. Ph., 03
Gnambodoe-Capochichi, Martine, 22
Hackett, Gregory A., 2G
Hidalgo, P., 2D
Hierro, Adrian, 19, 2C
Hinkov, Borislav, 19
Hugues, Maxime, 19, 2C
Izumskaya, N., 17
Jaeck, Julien, 19
Jakata, Kudakwashe, 23
Jee, Youngseok, 1X, 2G
Jollivet, Arnaud, 19
Julien, François H., 19
Kalapos, Thomas L., 2G
Kamal, 2Q
Karjalainen, Antti, 10
Kityk, I. V., 24
Kuramata, Akito, 13, 16
La Rue, Gavin, 2O
Le Biavan, Nolwenn, 19, 2C
Lee, Shiwoo, 2G
Lefebvre, D., 2C
LeMaire, Peter K., 2P
Le Pivert, Marie, 22
Leprince-Wang, Yamin, 22
Lérondel, G., 03
Leung, Tik Lun, 1K, 2K
Li, Wen, 1W
Liao, Y., 16
Lin, Jenshan, 16
Liu, Changwen, 05
Liu, Fangzhou, 1K, 2K
Lynn, Kelvin G., 0Z
Makkonen, Ilja, 10
Marañón, V., 1J
Marty, Frédéric, 22
Matulionis, A., 17
McClintock, R., 1H
McCluskey, Matthew D., 0Z
Méndez, Bianchi, 1S, 2D
Mondal, Aniruddha, 2L
Montes Bajo, Miguel, 19, 2C
Morkoç, H., 17
Murkute, Punam, 1P, 2F, 2H, 2I, 2J,
 2L, 2M, 2N

- Mustafa, Elfatih, 25
 Netesova, Nadezhda P., 2B
 Ng, Alan Man Ching, 1K, 2K
 Ng, Annie, 05
 Njoroge, Eric G., 23
 NÓ, María L., 1S
 Nogales, E., 1S
 Nur, O., 25
 Ohodnicki, Paul R., Jr., 1X, 2G
 Ordouie, Ehsan, 2O
 Ozga, K., 24
 Özgür, Ü., 17
 P., Poornesh, 24
 Patakfalvi, R., 1J
 Pearton, S. J., 16
 Pérez, H., 1J
 Petwal, Vikash Chandra, 24
 Philip, Reji, 24
 Phillips, David Lee, 05
 Pirotta, Stefano, 19
 Prajapati, Y. K., 2Q
 Prozheeva, Vera, 10
 Razeghi, M., 1H
 Ren, Fan, 16
 Ren, Zhiwei, 05
 Ritter, Jacob R., 0Z
 Rodríguez, R., 1J
 Rogers, David J., 1H
 Rosendo, E., 1J
 Sabry, Yasser M., 22
 San Juan, José M., 1S
 Sandana, V. E., 1H
 Sanjeev, Ganesh, 24
 Sasaki, K., 13
 Sato, R., 1J
 Šermukšnis, E., 17
 Siahmakoun, Azad, 2O
 Singh, Abhishek, 2Q
 Singhal, Rahul, 2P
 Smith, David J., 16
 Strasser, Gottfried, 19
 Surya, Charles, 05
 Sushama, Sushama, 1P, 2F, 2H, 2I,
 2L, 2M, 2N
 Tadjer, Marko, 16
 Tam, Ho Won, 1K, 2K
 Tamayo-Arriola, Julen, 19, 2C
 Tchernycheva, Maria, 19
 Teherani, Ferechteh H., 1H
 Thapa, Juddha, 21
 Tuomisto, Filip, 10
 Ulloa, J. M., 2C
 Vennéguès, P., 2C
 Verma, Vijay Pal, 24
 Wagner, Gunter, 10
 Wamwangi, Daniel M., 23
 Wang, Chao, 1A
 Wang, Yingce, 1A
 Willander, M., 25
 Wittkowski, Thomas, 23
 Wong, Victor, 1G
 Woodruff, Steven D., 21
 Wu, Binlin, 2P
 Wu, Jiajia, 1W
 Wuenschell, Jeffrey K., 1X, 2G
 Yamakoshi, S., 13
 Yang, Jiancheng, 16
 Yang, Weiyang, 1W
 Zhang, Jingwen, 1A
 Zhao, Hua, 1A
 Zhu, Ruixue, 05

Conference Committee

Symposium Chairs

Connie J. Chang-Hasnain, University of California, Berkeley
(United States)
Graham T. Reed, Optoelectronics Research Center (United Kingdom)

Symposium Co-chairs

Sailing He, KTH Royal Institute of Technology (Sweden) and Zhejiang University (China)
Yasuhiro Koike, Keio University (Japan)

Program Track Chairs

James G. Grote, Photonics Consultant (United States)
Shibin Jiang, AdValue Photonics, Inc. (United States)

Conference Chairs

David J. Rogers, Nanovation (France)
David C. Look, Wright State University (United States)
Ferechteh H. Teherani, Nanovation (France)

Conference Program Committee

Vitaliy Avrutin, Virginia Commonwealth University (United States)
Philippe Bove, Nanovation (France)
Ekaterine Chikoidze, Université de Versailles Saint-Quentin-en Yvelines (France)
Jean-Jacques Delaunay, The University of Tokyo (Japan)
Aleksandra B. Djurišić, The University of Hong Kong (Hong Kong, China)
Michael D. Gerhold, U.S. Army Research Office (United States)
Michael A. Harper, CIV USN ONR GLOBAL (United States)
Adrián Hierro, Universidad Politécnica de Madrid (Spain)
Axel Hoffmann, Technische Universität Berlin (Germany)
Na Lu, Purdue University (United States)
Bianchi Méndez, Universidad Complutense de Madrid (Spain)
Norbert H. Nickel, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany)
Tatsuo Okada, OPERA Center for Organic Photonics and Electronics Research (Japan)
Ümit Özgür, Virginia Commonwealth University (United States)

Seong-Ju Park, Gwangju Institute of Science and Technology
(Korea, Republic of)
Manijeh Razeghi, Northwestern University (United States)
Federico Rosei, Université du Québec (Canada)
Vinod Eric Sandana, Nanovation (France)
Michael L. Schuette, Air Force Research Laboratory (United States)
Chris G. Van de Walle, University of California, Santa Barbara
(United States)
Bruno Viana, Ecole Nationale Supérieure de Chimie de Paris (France)
Markus R. Wagner, Technische Universität Berlin (Germany)
Magnus Willander, Linköping University (Sweden)
Hideki Yamamoto, NTT Basic Research Laboratories (Japan)

Session Chairs

- 1 Kick-off Session
David J. Rogers, Nanovation (France)
- 2 Keynote Session
David J. Rogers, Nanovation (France)
- 3 Ultra Wide Bandgap Oxide Semiconductors: Density Functional Theory and Modelling
Markus R. Wagner, Technische Universität Berlin (Germany)
David C. Look, Wright State University (United States)
- 4 Deep Levels and Irradiation Induced Defects in Ga₂O₃
Kelson Chabak, Air Force Research Laboratory (United States)
David C. Look, Wright State University (United States)
- 5 Ultra Wide Bandgap Oxide Semiconductors: Progress in Thin Film Growth I
Philippe Bove, Nanovation (France)
Catherine Dubourdieu, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany)
- 6 Ultra Wide Bandgap Oxide Semiconductors: Progress in Thin Film Growth II
Catherine Dubourdieu, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany)
Philippe Bove, Nanovation (France)
- 7 Ultra Wide Bandgap Oxide Semiconductors: Progress in Thin Film Growth III
Markus R. Wagner, Technische Universität Berlin (Germany)
David J. Rogers, Nanovation (France)

- 8 Ultra Wide Bandgap Oxide Semiconductors: Doping and Band Structure
Vinod Eric Sandana, Nanovation (France)
Cuong Ton-That, University of Technology, Sydney (Australia)
- 9 Ultra Wide Bandgap Oxide Semiconductors: Applications
Vinod Eric Sandana, Nanovation (France)
David J. Rogers, Nanovation (France)
- 10 2D Materials and Quantum Structures
Vitaliy Avrutin, Virginia Commonwealth University (United States)
Adrián Hierro, Universidad Politécnica de Madrid (Spain)
- 11 Plasmonics
Vitaliy Avrutin, Virginia Commonwealth University (United States)
Adrián Hierro, Universidad Politécnica de Madrid (Spain)
- 12 Oxide-based Energy Harvesting and Solar I
Magnus Willander, Linköping University (Sweden)
David J. Rogers, Nanovation (France)
- 13 Oxide-based Energy Harvesting and Solar II
Magnus Willander, Linköping University (Sweden)
David J. Rogers, Nanovation (France)
- 14 Photon-induced Phenomena in Oxides
Philippe Bove, Nanovation (France)
- 15 Tuning Transmittance and Reflectance from UV to IR
Aleksandra B. Djurić, The University of Hong Kong
(Hong Kong, China)
Vinod Eric Sandana, Nanovation (France)
- 16 Oxide-based Gas Sensors
Philippe Bove, Nanovation (France)
- 17 Specialized Characterization
Philippe Bove, Nanovation (France)
Matthew Putman, Nanotronics Imaging, Inc. (United States)
- 18 Oxide Nanostructures and Applications
Magnus Willander, Linköping University (Sweden)
- 19 Tuning Electrical Properties
Vitaliy Avrutin, Virginia Commonwealth University (United States)
Vinod Eric Sandana, Nanovation (France)

20 Emitters and Detectors

Philippe Bove, Nanovation (France)

Adrián Hierro, Universidad Politécnica de Madrid (Spain)